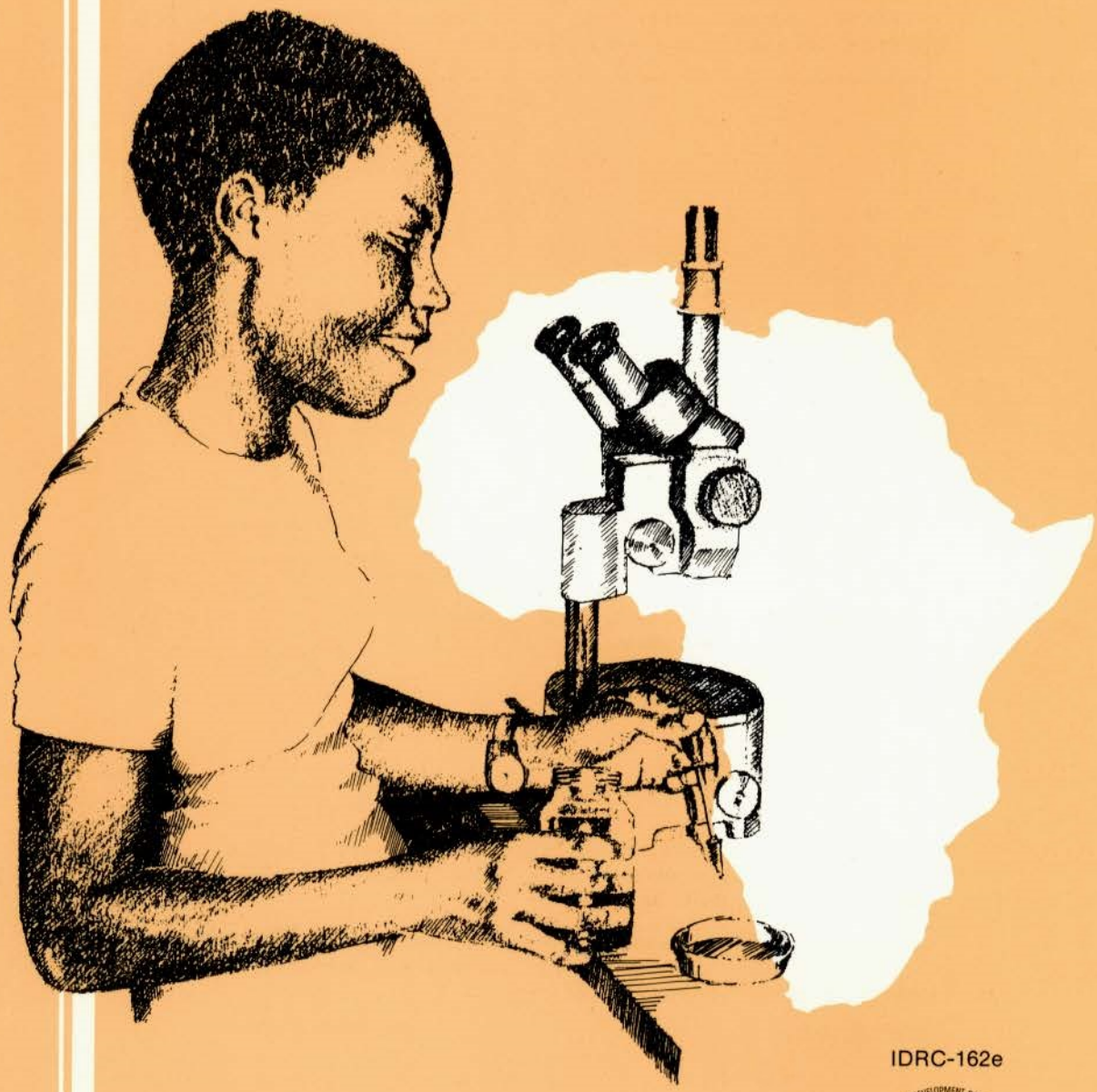
Priorities for Science and Technology Policy Research in Africa



Report of a seminar held at the University of Ife, Ile-Ife, Nigeria, 3-6 December 1979

IDRC-162e

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IDRC-162e

Priorities for science and technology policy research in Africa : report of a seminar held at the University of Ife, Ile-Ife, Nigeria, 3–6 December 1979. Ottawa, Ont., IDRC, 1981. 32 p. : ill.

/IDRC publication/, /research/, /science policy/, /policy making/, /Africa/ — /research policy/, /decision making/, /research and development/, /research projects/, /conference report/.

UDC: 6.001.1(6) ISBN: 0-88936-279-3

Microfiche edition available

Il existe également une édition française de cette publication (IDRC-162f).

IDRC-162e

Priorities for Science and Technology Policy Research in Africa

Report of a seminar held at the University of Ife, Ile-Ife, Nigeria, 3–6 December 1979

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Preface

In 1973 the International Development Research Centre (IDRC) and the Economic Commission for Africa (ECA) jointly sponsored a meeting of Africans interested in technology policy research. This meeting took place at the University of Ife in Nigeria.

In the years following that meeting the number of individuals and institutions involved in technology policy research grew in Latin America and Asia, but there was relatively little growth in Africa. It was therefore decided by both IDRC and ECA to convene a second African meeting on this theme. This took place, also at the University of Ife, in December 1979. The purpose of this meeting was to take stock of the present situation and to discuss ways in which technology policy research in Africa might be developed. The local host for the meeting was the Technology Planning and Development Unit at the University of Ife and the staff of that Unit, under the direction of Dr D. Babatunde Thomas, prepared this report of the meeting.

IDRC is distributing the report in the hope it will stimulate discussion in Africa on the ways in which technology policy research might be further developed in that continent.

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Introduction

In the early part of the 1970s, a number of attempts were made to bring about awareness of science and technology (S and T) policy research in the Third World. As a multidisciplinary field of study primarily emerging (in the post-World War II era) from the social science disciplines of development and growth economics, its importance in policy decision-making on national development is already evident in most parts of the world, but not in Africa. At a meeting at the University of Ife in 1973, the first major effort in Africa was made to bring about awareness of the field as a potentially useful input into the formulation and implementation of national and regional development policy. That initial effort was followed in December 1977 by a meeting in Kericho, Kenya, to stimulate interest by bringing together researchers and policymakers from various parts of Africa. In mid-1979, C.H.G. Oldham and D.P.S. Wasawo, Chief, Natural Resources Division, Economic Commission for Africa, Addis Ababa, Ethiopia, consulted on the relevance and wisdom of convening another meeting during 1979 to put the outcomes of the two previous meetings in their proper perspectives and identify priority themes for research. Dr Oldham then sent out letters of inquiry to S and T policy researchers and policymakers in several African countries to ascertain the need to convene another meeting in Africa in 1979. Considerable interest was shown in such a meeting and at the request of Dr Oldham, the Technology Planning and Development Unit at the University of Ife agreed to act as host.

The meeting had the following objectives:

(1) to discuss S and T policy research priorities for the Africa region against the background of previous meetings and conferences;

(2) to generate, and discuss in detail, a list of priority topics that would provide a framework for collaboration between groups of researchers in the region and for complementarity of resources;

(3) to formulate the outline of a research program on certain themes;

(4) to discuss follow-up research programs; and

(5) to discuss follow-up actions that would foster S and T policy research in Africa.

The workshop was held from 3 to 6 December 1979 and was attended by participants from nine African countries.

In his opening address, the Vice-Chancellor of the University of Ife, Professor Cyril A. Onwumechili, extended a warm welcome to all the participants, traced a history of past efforts to generate interest and promote work in S and T policy research in Africa, and discussed the timeliness of the workshop, which was convened soon after the conclusion of the United Nations Conference on Science and Technology for Development (UNCSTD) in Vienna in August 1979. The Vice-Chancellor urged the participants to ensure that the workshop did not turn out to be "just another session of talks about what we should be doing, but that it

should strive to achieve the objectives identified and to come up with some practical solutions to the problems which form the basis of those objectives.

Three other opening addresses were given by: T.S. Karumuna, Science and Technology Unit, Economic Commission for Africa (ECA); C.H.G. Oldham; and Professor S.A. Sanni, Dean, Faculty of Technology, University of Ife. In the three addresses, the need to draw upon the experiences of past meetings, workshops, and conferences was emphasized.

Mr Karumuna highlighted the concerns about technology policy and planning in the Africa region and the prevailing position in the ECA on its role in the region's development. These points were buttressed by citing from a 1977 report of the interagency mission on the establishment of an African Regional Centre for Transfer, Adaptation and Development of Technology. The members of the mission observed that few of the countries had explicit policy in the field of technology. In the great majority of countries, the possibilities of technology policy as an instrument of development were only implicitly perceived. Few countries had reached the stage of consolidating their policy, explicit or implicit, in a plan of action for strengthening their technological capability. This absence of policy is largely due to the general lack of awareness of the pervasive nature of technology in national development. Where there was such an awareness it was largely scattered in the decision-making system and, therefore, had little impact on the national process of policy formulation. As a result, policy was often pursued in an uncoordinated or contradictory fashion. Mr Karumuna outlined the major importance ECA attaches to S and T policy research both as a field of study and as an input to aid policymakers in the difficult task of deciding on the application of science and technology for socioeconomic development. In this respect, he indicated that efforts are under way in ECA to support member states in the promotion of S and T policy research.

Drawing upon the experiences of past meetings, and in particular the first Ife meeting in 1973, Dr Oldham outlined why the aspirations of that meeting were not fulfilled and gave some of the reasons for the languishing state of science and technology policy studies in Africa since the early 1970s, while "they continued to grow and prosper in other parts of the Third World." He observed that the results of S and T policy research in other Third World countries played an important role in the knowledgeable and decisive position taken by the Group of 77 at UNCSTD in Vienna.

Emphasizing the charge of the Vice-Chancellor and W.K. Chagula, Ambassador, Permanent Mission of Tanzania, Geneva, that "the time for talk was over; now there must be action," Dr Oldham outlined the conditions for a successful policy research program. The research emanating from the program must be academically sound and should influence the actions and decisions of policymakers. In this respect he identified five necessary ingredients: (1) the existence of "a need for the policymakers to want the results of policy research, i.e., there must be a demand for the new knowledge generated from policy studies; (2) there must be institutions where the research can be carried out; (3) there must be researchers who can do the research; (4) there must be a research program made up of a number of related research projects; and (5) there must be the money to enable the research to be carried out.

He further stated that discussion of African countries' priorities in general, and the detailed discussion of specific priority topics, can provide a useful framework both for collaboration between different groups and for formulation of specific research agendas in various institutions. He commended the participants

for sharing a common goal, namely, a commitment to the development of science and technology policy research in Africa, and outlined the catalytic role that IDRC is playing in the development of the field and the Centre's past and continuing financial support for policy research. He concluded by pointing out that "good policy research is an essential part of scientific and technological self-reliance" and hoped that through the workshop, "new science and technology policy programs would emerge and flourish throughout Africa."

Professor S.A. Sanni outlined the history of the Technology Planning and Development Unit at the University of Ife and the difficulties that were encountered in staffing, generating financial support for projects, and in overall program development. Some of its past and current activities were also reviewed. Focusing on the importance of the workshop's objectives, in particular the need for the training of manpower to carry out S and T policy research in the Africa region, he urged local and foreign sources of support to promote rapid and effective training of policy researchers and policymakers.

The workshop agenda focused on: (1) a keynote paper and a discussion of the paper; (2) identification of priorities for S and T policy research; (3) manpower requirements and training; (4) research project proposals; and (5) follow-up activities.

The convening of the workshop was made possible by IDRC and ECA, and in particular by the financial support of both IDRC and the National Science and Technology Developrnent Agency (NSTDA), Cabinet Office, Lagos, Nigeria. In this respect two people deserve special thanks for their personal support in ensuring the timely funding of the workshop: C.H.G. Oldham and V.O.S. Olunloyo, Executive Secretary, NSTDA, Lagos. The success of the workshop is due to the dedication and effective contributions of the participants. A number of people assisted the Technology Planning and Development Unit staff in organizing the workshop: among these, S.A. Sanni, Pat Ladipo, L.O.A. Anise, and O.A. Oguntoye deserve special thanks. The faculty of technology secretarial staff also deserve special thanks for their services during and after the workshop.

Keynote Paper

Science and Technology Policy Research in Africa: Challenges and Prospects

D. Babatunde Thomas[1]

The Basis of S and T Policy Research

The establishment of national science and technology policy usually recognizes the need to stimulate and mobilize actual as well as potential S and T resources for the attainment of national socioeconomic objectives. But, the establishment of a policy in and of itself has no sound basis unless it is a result of appropriate S and T policy research and is consistent with overall development objectives.

In a general sense, S and T policy research embraces the study and the understanding of the socioeconomic environment and the development and delineation of information on prevailing conditions. The knowledge thus obtained is a vital input into decision-making on the choice and use of S and T services as tools for development. The specific use of the resultant information may take place at two levels: at the microlevel for choice-making on the development and use of scientific and technological services; and at the macrolevel for the establishment of guidelines for future development trends in the demand and supply of S and T services based on the dynamics of the national and international socioeconomic environment. In the latter case, the information obtained is essential in assessing the effectiveness of existing policies and the need for changes and/or reorientation.

During the past decade, several African countries have established institutions to oversee the national development of scientific activities and have attempted to establish national policies. "Scientific Research Councils" and broad "scientific development policies" have been created. The approach taken to the activities of the councils and the formulation of policies was to treat scientific developments as the determining constituent of technological development. The tendency, therefore, has been to view science and technology as inseparable elements. Modern science and modern technology are necessarily interdependent but not necessarily inseparable. The emerging holistic approach to S and T matters obviates the recognition of the dissimilarity in the pursuit of scientific and technological activities[2] and, furthermore, contradicts certain historical and prevailing conditions in most African countries.

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[1]Director, Technology Planning and Development Unit, University of Ife, Ile-Ife, Nigeria. The author benefited from the comments of L.O.A. Anise and Earl Eames Jr.

[2]For further discussion of this point, see Merton, R., The Sociology of Science, University of Chicago Press, Chicago, Illinois, 1973.

In these countries, empirical, or what is often referred to in the context of underdevelopment as "rural" or "traditional," technology has historically been an integral part of the socioeconomic environment. Its development in the areas of ironworks, leatherworks, pottery, etc., has responded to the needs of the masses for direct productive activities and for creative drive. Although "traditional" technology predates modern (science-based) technology, over time, the social and economic basis for modernization has occasioned a decline in the role of the former. The increasing interest in modern science and the increasing acquisition of science-based technologies, encouraged by their demonstrated effects in the advanced countries, were major factors in social and economic modernization and the resultant steady decline in the application of "traditional" technology. The absence of a link between "traditional" technology and modern science-based technology (both of which are culturally divergent avenues of knowledge formation and utilization) precluded: (1) the reinforcement of "traditional" technology by modern technology; and (2) the internalization of modern technology in attempts to modernize the "traditional" sector. Unlike "traditional" technology, modern science and science-based technology tends to be active on the periphery of the socioeconomic environment inhabited by the masses.

The relationship of that socioeconomic environment to S and T activities in the context of the underdevelopment is illustrated in Fig. 1. The circle A represents the socioeconomic environment. Circles B and C represent the relative magnitudes of "traditional" technology and modern (science-based) technological activities, respectively.

The intersections A Ω B and A Ω C that is, B and D, respectively, represent the extent to which these activities are part of the socioeconomic environment. D or A Ω C represents the extent to which modern (science-based) technology has

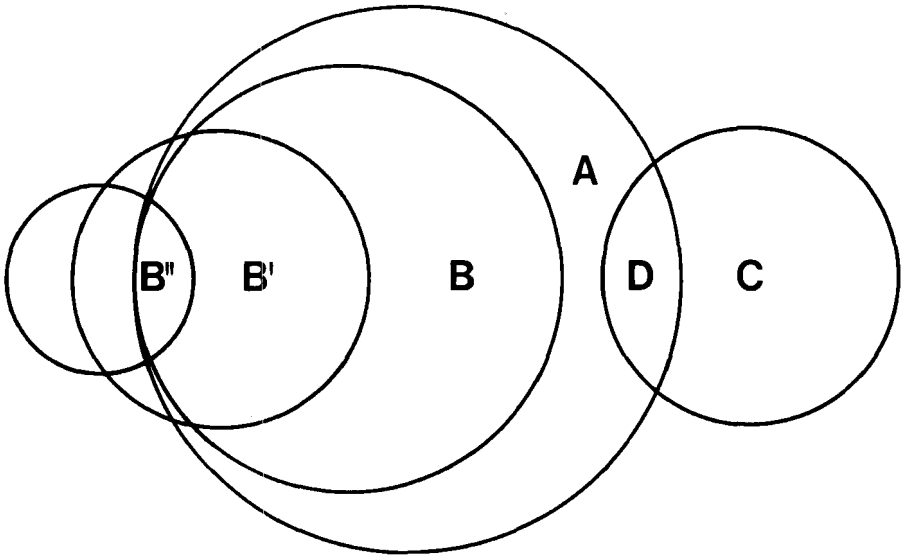

Fig. 1. Relationship of socioeconomic environment to S and T activities in the context of underdevelopment: (A) the socioeconomic environment; (B) empirical ("rural"/"traditional") technology; and (C) modern (science-based) technology.

been internalized in that environment. The declining role of "traditional" technology is represented by the reduction in $A \Omega B$ to $A \Omega B'$ and $A \Omega B''$ and in the relative sizes of B, B′, and B″. The nature of the fundamental divergence of the two avenues underscores the inappropriateness of a holistic approach to the design of S and T policy.

The implication of the decline in the role of "traditional" technology is for this activity and the socioeconomic environment, i.e., A and B, to eventually become mutually exclusive sets and thus compel a complete dependence on the importation of modern technology. Given this implication and the impediments to the rapid internalization of modern technology, policies must define new paths for the rediscovery and revitalization of "traditional" technology and, where and when appropriate, integrate its development with increasing internalization of modern technology. That is, to increase D in proportion to the rapid rate of global expansion in S and T development. These are critical issues for which S and T policy research is an essential input.

The field of S and T policy research emerged less than three decades ago. Although it is relatively new worldwide, its growth has been rapid. Furthermore, most of the activities in the field are concentrated in the advanced countries and a few LDCs in Latin America and Asia.

S and T Policy Research in African Countries

In December 1973, the International Development Research Centre (IDRC) and the Economic Commission for Africa (ECA) sponsored a meeting at the University of Ife on the creation of centres for technology policy studies in Africa.

One of the objectives of the 1973 meeting was to promote the study of technology policy and planning in African countries with the view to: (1) enlarging the technological capacity of these countries; and (2) promoting the effective use of this capacity in their socioeconomic development. At the end of the meeting, a number of recommendations were made: (1) the establishment of multidisciplinary groups in African countries to conduct technology policy studies; (2) the conduct of seminars to assist with the formation of these groups; and (3) the establishment of a regional program to promote cooperation among the national groups that were formed.[3] At that meeting, the University of Ife announced its decision to establish "an organization especially oriented to study the economic, social, and technological factors involved in industrial development.

That organization was formally established in 1974 as the Technology Planning and Development Unit (TPDU). Foremost in the objectives of the unit are: (1) the conduct of S and T policy studies on Nigeria; and (2) the application of the results from these studies to assist government and its policymaking bodies in reaching major decisions on the S and T components of national development planning and in implementing these decisions to build up and utilize relevant capabilities in various sectors of the economy. The difficulties involved in the development and functioning of the unit are part of the inherent challenge of

[3]See Technology Policy Study Centres in Africa: report on the IDRC/ECA meeting on the creation of centres for technology policy studies in Africa, Ile-Ife, Nigeria, 5–10 December 1973. International Development Research Centre, Ottawa, Canada, IDRC-027e. (This publication is now out of print but can still be obtained on microfiche.)

building and using local capabilities for the conduct of S and T policy research. The experience of TPDU is common to similar units elsewhere.

In the last decade, a number of meetings and workshops similar to the 1973 meeting have been convened at the national, regional, and global level. The foci of these meetings typically included the broad question of how to harness S and T for development and related policy issues.[4] Despite the large number and the magnitude of several of these meetings, conferences, and workshops, concrete results have been few and far between. Although the buildup of S and T capabilities in the LDCs requires a long-term perspective, the dismal performance and results from these meetings and follow-up activities have created skepticism and concern about the need for the "jamborees."

Taking the 1973 meeting as the starting point af a major effort to promote and develop S and T policy research in Africa, the record in the 6 years that have elapsed is a dismal one in terms of a lack of support for the recommendations of the meeting and thus a virtual stagnation of activities in S and T policy research. Although the outcomes of recent meetings such as the OAU/ECA Symposium and UNCSTD suggest some promise of positive changes in the buildup of S and T capabilities in Africa, as well as recognition of the need for the development and proper orientation of technology policy, the role of policy research in these efforts has yet to be acknowledged or attempts made to develop the requisite capabilities.

Among the key S and T policy issues addressed by the OAU/ECA Symposium were the need to: (1) develop capabilities for the formulation of autonomous S and T policy on "the most pressing needs and problems of Africa"; and (2) increase the social usefulness of the active population through employment.[5] Also, at least three S and T policy issues that are pertinent to the African context are essential elements of target areas A and B of UNCSTD's draft program of action. These are the need to design and direct policies to: (1) provide for a range of technologies from basic to the most sophisticated; (2) arrive at an optimum combination of capital and noncapital intensive technologies in a country-specific, resource-specific, and product-specific pattern; and (3) facilitate the sharing of experiences among LDCs and coordinate their policies with respect to internal legislation on industrial property, foreign investments, and transnational corporations for the selection, acquisition, adaptation, assessment, and development of technologies.[6] The successful pursuance of these objectives is dependent on inputs from the conduct of pertinent S and T policy research.

It is uncertain that there is a general lack of S and T policy among African countries. As far back as 1972, 38 countries of the Conference of Ministers of African Member States Responsible for the Application of Science and Technology to Development (CASTAFRICA) indicated the existence of (implicit

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[4]Some key examples of these meetings, workshops, and conferences are: the IDRC meeting on the Use of Scientific Capabilities to solve the Technological Problems of Rural Development (Dar es Salaam) 1975; the IDRC/ECA meeting on S and T Policy (Kericho), 1977; the UNESCO/UNISIST (World Information System in Science and Technology) Inter-govemmental Conference on S and T Information for Development and the meeting on Regional Information policy planning in West Africa (Paris, Accra) 1971, 1979; the OAU/ECA "Symposium on the Future Development Prospects of Africa Towards The Year 2000" (Monrovia) 1979; and UNCSTD (Vienna) 1979.

[5]U.N., Final Report of the "Symposium on the Future Development Prospects of Africa Towards The Year 2000." E/CN.14/698/Add.2, E/CN.14/TECO/44/Add.2; p.3.

[6]UNCSTD Document A/CONF.81/L.1.

or explicit) S and T policy in their countries.[7] Presumably that number has increased. What the evidence on the structure and impact of S and T policies in these countries suggests is: the absence of substantive inputs from policy research; seeming inconsistencies with overall development objectives; and the inefficaciousness of the policies. Although the question of whether the inadequacy of existing policies is due solely to the lack of input from policy research does warrant some further analysis, the question may be difficult to answer empirically. However, such inputs are vital to the design, proper orientation, and effective implementation of S and T policy.

The impediments to the development of S and T policy research in Africa are multidimensional. The following are three critical aspects: (1) a general lack of awareness and hence lack of support at the highest level of government for S and T policy research as an essential input into the decision-making process on the buildup of scientific and technological capabilities as well as on overall socioeconomic development; (2) the policy and attitude of most international funding agencies not to provide support for program development but to limit support to project funding; and (3) the lack of a critical mass of capabilities, manpower, library, etc., that is related to the first two constraints.

Unlike the condition outlined in (1) above, international agencies are becoming aware of the importance of S and T policy research and are advocating its programmatic development. There are reasons to suggest that some researchers in this field in Africa view these agencies as possible sources of support for effecting the development of local awareness and funding support for S and T policy research. The prevailing state of affairs as engendered by the three foregoing constraints and the seeming lack of interest in S and T policy research by the private sector appear to have impeded the vigorous development of viable capabilities for the conduct of S and T policy research and the use of its results for the design of practicable and virile policies.

Challenges and Prospects

The challenges of S and T policy research are both immense and complex within the context of the stages of development in Africa. They range from understanding the articulated socioeconomic objectives of the society to bringing to bear the information and results from these studies on developing, stimulating, and mobilizing S and T resources in the pursuance and attainment of established objectives. Other specific challenges include: (1) the policy researchers' problems of how to improve the poor awareness of political decision-makers and how to solicit and obtain their support for the conduct of policy research; (2) the complexity of the sociocultural environment, much of which has yet to be adequately understood by those professionally equipped to study the social conditions but possibly culturally handicapped by that same professional training; (3) how to identify scientific and technological constraints to national development; (4) how to develop and utilize the limited data presently available in the conduct of policy studies necessary for the design of autonomous national policies rather than the mere replication of advanced countries' strategies; (5) how to develop appropriate capabilities — manpower, library, etc., and (6) how to link

[7]See National Science Policies in Africa, UNESCO Science Policy Studies Documents, Series No. 31, Paris, 1972, p. 13.

programs in S and T policy research inside and outside of government with policymaking bodies in a support or advisory capacity.

On the basis of the prevailing conditions as to the degree of awareness and support for policy research, it could be concluded that the prospects of meeting these challenges are ill-lit. There is a general recognition of the need for a break with the past in the effort to devise strategies and policies for the scientific and technological development of Africa. Constraints to building capabilities for the conduct of S and T policy research and to the use of output from such studies as input into the design of strategies and policies are essential considerations in defining new paths for development.

This paper is an attempt to examine briefly some of the current challenges facing the pursuit of purposeful S and T policy research in Africa. The focus has been on the challenges, and by implication on the prospects, of conducting policy research and applying its results to national development. The prospects of meeting these challenges and enhancing the outlook for policy studies will depend on how much African policy researchers, scientists, and technologists intensify their efforts to reach national policymakers with the view to ensuring that: (1) S and T policy research is encouraged and adequately supported; and (2) appropriate mechanisms are developed for the integration of S and T with national development planning as well as with the implementation of development programs and projects.

Discussion[8]

The discussion of the foregoing paper focused on further elaboration of its main foci.

Political awareness in Africa was achieved as a result of the independence struggle. The task the region now faces is to struggle and bring about a comparable level of scientific and technological awareness. There is a need to improve the awareness of decision-makers about the need for S and T policy research through various forms of actions. Decision-makers need to recognize that technology as embodied in technical know-how is a pivotal factor in the acquisition of economic power. As a vital resource, it must be developed as a matter of urgency and managed with a high degree of competence.

The extent to which awareness by decision-makers can be considered a problem varies from one African country to another. However, what seems universal is the extent to which decision-makers have become frustrated and disappointed because national investment in S and T, though small, has produced no visible dividends so far. The question then is: How can this situation be changed? Periodic national conferences should be encouraged to bring together political decision-makers, S and T decision-makers, and S and T policy researchers. This forum should be designed to bridge the existing gaps between and among the three groups and to promote continuing interactions among them. The systematic delineation of existing (explicit and implicit) S and T policy instruments, the development of new and viable ones, and increased support are fundamental to the accumulation of visible dividends. The machinery for implementing and diffusing decisions and recommendations from conferences must be developed. S and T policy should be clear and concise and efforts should

[8]Rapporteurs: Professor P.O. Ngoddy and Mr G. Shifferaw.

be made to achieve integration of S and T policy into national development and, by so doing, to remove the existing dichotomy. Misconceptions on the part of political decision-makers about the motivation for S and T activities on the part of scientists and technologists also must be corrected. Another misconception that requires urgent correction is the thinking among certain political decision-makers that technology is simply hardware to be "transferred," acquired, and readily benefited from. Technology is a stock of know-how and it needs to be continually and efficiently developed and carefully managed.

The inadequacy of trained scientific and technological manpower in many African countries must be corrected. To accomplish this goal, the development of S and T capabilities should be given high priority in manpower training programs. This need is different from the development of manpower for the conduct of S and T policy studies, which is an agenda item of the workshop and is discussed elsewhere in this report.

Identification of Priorities for S and T Policy Research

Two documents served as the background material for the discussion of project identification: (1) Topics for Research Themes, suggested by African Participants at the ECA/IDRC Meeting on Technology Policy Research, Kericho, Kenya, December 1977; and (2) A Priority List of Science and Technology Policy Research Themes for Nigeria, prepared by the Technology Planning and Development Unit, University of Ife, November 1979 (see Appendix 1). The two documents were reviewed as a basis for the global identification of projects and priorities. As a prelude to the review of the documents, the workshop outlined some guideposts for the drawing up of priority themes for research: (1) about 90% of the African population lives in and/or depends on the rural sector for their subsistence living; (2) the development of the rural sector must be accorded paramount importance in the development of African economies; (3) the educational system must respond to the creative desires of the individual and to the practical needs of the societies; and (4) among the basic needs of the rural sector that require immediate attention are energy resources for food production and processing and health services for improved living conditions and for increased productivity.

The outcome of the preliminary review of the two documents consisted of an outline of: (1) broad issues of S and T policy studies; (2) some ancillary issues; and (3) additional research themes.

Broad Issues of S and T Policy Studies

(1) The importance, the role, and the need for S and T policy research as a vital input into the formulation of development policy.

(2) Why and how S and T policy can become an integral part of the socioeconomic planning process.

(3) How to popularize S and T and S and T policy research for purposes of awareness and public pressure for social change.

(4) How the S and T information systems could be developed and operationalized.

Ancillary Issues

(1) Meeting R and D demand outside the S and T system of African countries.

(2) Assessing the impact on African countries of the radical technical changes taking place in the industrialized countries.

(3) Understanding why and how to respond to the failure of ongoing technical change to catalyze further changes through linkage effects.

Additional Research Themes

(1) Research on African indigenous technology.
(2) Adoption of R and D innovations.
(3) Development of appropriate science curricula.
(4) Mechanisms for policy implementation.
(5) Institutional infrastructure for coordination of S and T activities.
(6) Mechanization of agricultural processing at the cottage level.
(7) Estimating R and D funding needs and returns.
(8) Improvement of nutrition in the rural areas.
(9) Policies on derivation costs and control of construction.
(10) Policies on petroleum products.
(11) Examination of policies on fuel alternatives: hydroelectric, coal, and, at the village level, wood, bio-gas, and solar energy development.
(12) Preventive and curative traditional medicine.
(13) Development of modern methods of fishing.

In the search for a clarification of the issues and research themes that underlie the foregoing lists, a number of contributions were made by Martin Bell. These included "an outline of main functions within the S and T systems," a list of "policy (decision) questions," and a list of "tasks and questions for S and T policy research" (see Appendix 2).

Carrying the task of project identification one step further, the following broad sector-specific and policy-function areas for priority research were outlined without any ranking.

Sectors

(1) Food and Agriculture; (2) Agroindustries; (3) Manufacturing; (4) Energy; (5) Transportation and Communication; (6) Building and Construction; (7) Health Care Services and Environment; (8) Manpower; (9) Rural Development; and (10) Mining.

Policy Functions

(1) R and D; (2) Training, Education, and Popularization; (3) Acquisition of Technology; (4) Capital Goods; (5) Traditional Technology; (6) Rural Modeling; (7) Policy Formulation and Implementation; (8) Operation, Maintenance, and Continuing Improvement; (9) Engineering Services; and (10) S and T Information Systems.

These sectors and policy functions can be viewed as rows and columns with the cells in the matrix serving as the focus for policy research projects. For example the intersection of the third sector — Manufacturing — with the ninth policy function area — Engineering Services — could represent a research focus. Following further review of the sectors and policy functions, several approaches to the identification of priority themes were discussed and various questions were raised about the implications of compiling a list of priority research themes by the collectivity of the participants. For example, should the themes lend themselves to national consideration only or to regional consideration as well? The workshop resolved that an attempt should be made to arrive at sectoral priority research themes for the Africa region that individual participants could use later as a basis for the formulation of national or regional research projects.

To streamline the task of project indentification and compile sectoral priority research themes, three areas were identified for focus: (1) Food and Agriculture (Agroindustries and Rural Development, i.e., sectors 1, 2, and 9); (2) Industry

(Manufacturing, Mining, and Construction, i.e., sectors 3, 6, and 10); and (3) Infrastructure and Services (Energy, Transportation, Communication, etc., i.e., sectors 4, 5, 7, and 8). Three subgroups were constituted for each of the three areas to deliberate on all the policy functions and present priority research themes.

The following are the summaries of the priority research themes in rank order from the three subgroups.

Food and Agriculture (Agroindustries and Rural Development)[9]

(1) Food, Agriculture, and Rural Development

(a) Education, training (manpower), and popularization

(b) Research and development

(2) Agroindustries and Rural Development

(a) Education, training (manpower), and popularization

(b) Policy formulation and implementation

(3) Overall Ranking of Policy Functions

(a) Education, training (manpower) and popularization: (i) Policy research to ensure appropriate training for effective agricultural "extension" manpower; (ii) Research into policy obstacles militating against effective "extension" work, e.g., attitude of farmers, bureaucratic problems, socioeconomic factors etc.; (iii) Research into the most effective ways of linking the research capabilities of scientists with the needs of farmers; (iv) How to bring about positive attitudes toward technological policies for policymakers; (v) Policy research into the role expectations of extension workers; (vi) Policy research into managerial, technological, and scientific manpower requirements; (vii) Research into the capabilities of the existing research institutions; and (viii) Research into comparative analysis of manpower development in other nations.

(b) Research and development: (i) Research into appropriate institutional infrastructure for R and D on food and agriculture such as evaluation of the role of existing research institutions in food and agriculture and their future orientation; (ii) Policy research to promote the utilization of research results (e.g., hardware developed in institutions); and (iii) Research into the training of R and D manpower including scientific and managerial skill.

(c) Policy formulation and implementation for agroindustries: (i) Review of existing government policies on agroindustries; (ii) Policy instruments that can encourage integrated planning for agroindustries, covering such things as quality and quantity of raw materials, supply of technology, storage, distribution etc.; (iii) The relationship between agroindustry and employment levels (focus on labour intensive techniques); (iv) Review of locations of agro-based industries; (v) Ownership and management patterns of agroindustries in relation to scale and location; and (vi) Instruments to facilitate implementation, such as: financing; subsidies; incentives; pricing policy etc.

Industry (Manufacturing, Mining, and Construction)[10]

(1) Manufacturing

(a) Acquisition of technology; capital goods; (b) R and D; (c) Policy formulation and implementation; (d) Operation, maintenance, and continuing

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[9]W.N. Masiga (Convener); R. Dodoo; Martin Kyomo; Patricia Ladipo; S.O.A. Osotimehin; Lydia Makhubu; G.F. Mbowe; P. Ngoddy; C.H.G. Oldham (Observer).

[10]A.K. Djeflat (Convener); L.O.A. Anise; O.O. Ewedemi; T.S. Karumuna; G.N. Mudenda; O.O. Oshinowo; Gizatchew Shifferaw; D. Babatunde Thomas; G.P. Uwujaren; M. Bell (Observer); C.H.G. Oldham (Observer).

improvement; (e) Engineering services and traditional technology; and (f) S and T information systems.

(2) Mining

(a) Acquisition of technology; (b) Capital goods; and (c) R and D, continuing improvement, operation, and maintenance.

(3) Construction

(a) R and D, acquisition of technology, development of traditional technology, and operation, maintenance, and improvement; (b) Education, training, and popularization; (c) Capital goods; (d) Policy formulation and implementation; (e) Engineering services; and (f) S and T information systems.

(4) Overall Ranking of Policy Functions and Related Questions/Issues

(a) Acquisition of technology — appropriate criteria for the acquisition of technology; criteria for unpackaging the technology; institutional framework and mechanisms are essential to successful technology acquisition. (b) R and D — how to develop R and D as a means of resolving local industrial problems, using local resources; what should be the role of R and D in preinvestment, investment, and postinvestment stages? (c) Capital goods — how to make appropriate choices of desired capital-goods industries based on defined development objectives; the need to and how to ascertain the local demand for capital goods; the need to and how to develop local capabilities for the production and maintenance of capital goods; why has the capital goods producing sector not developed in the African region and what have been the constraints? what forms of complementarities exist between capital goods and R and D, and S and T? what role does the capital goods sector play as a source of technical innovation? (d) Policy formulation and implementation — what are the institutional problems of policy formulation and implementation? what are the approaches to monitoring of policy implementation? why have past and existing S and T policies been ineffective? in what ways do technology policy formulation and implementation go against the interest of certain groups? how to popularize and demystify S and T; who are the people influencing policy on science and technology? what are the channels and mechanisms for influencing policymaking? how can these be operationalized so as to positively influence policymaking? what impacts do financial institutions have on technology policymaking? what apparatus within government is used to assess the investment and technology processes? (e) Operation, maintenance, and continuing improvement — what is the prevailing condition in respect of maintenance in the Africa region? why is the situation as it is? what do we do about it? what is the significance of these maintenance problems to the economy? what is the significance of the relationship between rate of equipment depreciation and maintenance? how important is the concept of learning-by-doing? how could maintenance be included as part of the acquisition process? what are the implications of poor maintenance or lack thereof for economic performance? (f) Training, education, and popularization. (g) Traditional technology — how could traditional technologies be harmonized with science-based technology? (h) Engineering services. (i) S and T information systems.

Infrastructure and Services (Energy, Transportation/Communication, Health Care, Manpower etc.)[11]

(1) Infrastructural Services

(a) Research and development (in manpower sector); policy formulation and implementation (in manpower development); (b) Rural energy models; operation

[11]A.B. Borishade (Convener); A.A.R. El Agib; B.A. Ajakaiye.

maintenance and continuing improvement (in energy sector); education training and popularization (in health care); policy formulation and implementation (in health care); (c) Policy formulation and implementation (in transportation/communication); operation maintenance and continuing improvement (in transportation/communication); research and development (in the health care services sector); traditional technology (in health care services including traditional herbs); and (d) S and T information systems (in energy); rural models (in health care services).

(2) Manpower

(a) Comparative studies of past policies in manpower development and the associated problems of implementation; (b) A survey of the resulting profile of manpower consequent upon previous policies; statistics of manpower categories in the various economic sectors; cost of manpower production; problems of manpower production; (c) The forecast of manpower required taking cognizance of the input and output of education and training services; and (d) Policy formulation: what new profile is needed assuming a development trend?; what educational and training systems are required for achieving this profile?; what is the cost of production of various categories of manpower?; the role of regional institutions in special manpower development.

(3) Energy

(a) A survey of past energy policies and implementation problems; (b) A study of available energy alternatives and consumption preference in rural and urban areas; (c) Modeling of suitable integrated energy systems considering appropriate local and regional factors; (d) Formulation of policies to ensure maximum cost effectiveness and social benefit; (e) Optimal implementation of policy decisions; and (f) Instruments of implementation of derived policies.

The foregoing summaries of the deliberations on project identification highlight, for the Africa region, priority policy functions and the explicit priority areas and themes for the conduct of policy research in the subsectors covered and are based on the perceptions of the participants.[12]

The participants agreed that this result from the deliberations on project identification represented a useful first step in any attempt to formulate research agendas in the various institutions and by the individual researchers in the African region.

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[12]Professor A.A.R. El Agib administered a questionnaire informally to ascertain how individual participants ranked each of the sectors and policy functions as well as the derived areas for policy research based on the two factors. The questionnaires were distributed to 20 participants belonging to the three subgroups. There were 18 respondents from the following countries: Algeria; Nigeria; Ghana; Tanzania; Kenya; Ethiopia; Zambia; Swaziland; and Sudan. The returns from the questionnaires indicated the following priorities in rank order. *Priority Sectors:* manufacturing; food and agriculture; agroindustries; energy; manpower; construction. *Priority Functions:* policy formulation and implementation; education, training, and popularization; acquisition of technology; R and D; operation, maintenance, and continuing improvement; engineering services. *Priority Areas for Policy Research:* engineering services in manufacturing; education training, and popularization in agriculture; acquisition of technology in manufacturing; R and D in food and agriculture; capital goods in manufacturing. Although these results were derived from an informal questionnaire, they have been included in this report in view of the high percentage of returns and their value in throwing some light on the results that emerged from the sectoral subgroups.

Manpower Requirements and Training

The participants agreed that the problems of meeting manpower requirements and the training of adequate manpower for the conduct of S and T policy research are fundamental to the successful development of S and T policy programs and the execution of pertinent projects. In a brief outline on the subject, Mr Osotimehin posed questions about: the general lack of financial support for S and T policy program development including manpower training; the prospects of major improvement in funding support; what is, and what should be, the role of national S and T commissions and the specialized agencies of the United Nations, in particular the ECA, and what are the constraints to the performance of their various roles? The following is a summary of the presentation and the discussions on the subject.[13]

There is an acute shortage of trained manpower to conduct S and T policy research in the African region. Problems of manpower training are immediate and must be accorded high priority and solved throughout the region. The development of training programs in the African region should be encouraged and supported financially by national S and T commissions and agencies, the ECA, and other regional as well as international agencies. The present role of international and regional agencies in this effort must be reviewed and redefined clearly in terms of local objectives. Training programs in general must be designed to generate multiplier effects such that a core group from each class of trained policy researchers goes on to train others. One of the few places where facilities and manpower exist for the training of the initial or core group to initiate such a training program is SPRU. While the core group is being trained, libraries and other facilities should be developed locally so as to enable the training program to commence on a sound footing. An alternative to group training programs is the training of individuals, as is the case currently. By complementing individual training with group training, the prospects of accelerating the buildup of a critical mass of policy researchers is enhanced.

The duration of training programs must allow for the minimum exposure necessary for those being trained to be able to apply the capabilities acquired. In this respect, training programs should also provide the necessary interface between policy research and policymaking to ensure that the outputs of policy research are effectively utilized by policymakers. One of the approaches to such an interface is periodic, or where feasible regular, joint training programs for policy researchers and policymakers. The training could be conducted by regional centres with teams assigned to conduct short-term traveling workshops and training sessions.

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[13]Mr Martin Bell made useful contributions to the discussions by sharing with the participants his experience from a training program — the IDRC Workshops on Science and Technology Policy Research for Development — which he has been conducting over the past few years at the Science Policy Research Unit (SPRU), University of Sussex.

The need to strenghten the S and T policy research capabilities of Africa is paramount to the formulation of viable policies on the scientific and technological development of the region, which thus far has been lacking. An essential requirement in meeting this need is the strategic development and the provision of necessary support for major programs throughout the region to train and increase the number and quality of local S and T policy researchers on a regular basis.

Research Project Proposals

Research proposals, outlines, and prospectuses on the following projects were presented to the workshop for discussion: (1) industrialization and the development of capital goods industry in Zambia (Investigator: G.N. Mudenda); (2) technology policy and industrial development strategy for Nigeria: development and growth of capital goods industry (TPDU Project) (Investigators: D. Babatunde Thomas; G.P. Uwajaren; and L.O.A. Anise); (3) technology policy issues in small-scale industries: a case study of metal and automobile repairs (TPDU Project) (Investigator: O.O. Ewedemi); (4) processing of agricultural products at the cottage level in Oyo State, Nigeria (Investigators: Patricia Ladipo et al.); (5) estimating returns to investment in R and D (TPDU Project) (Investigator: D. Babatunde Thomas): and (6) strategies and policies for energy development in Nigeria (Investigators: G.J.A. Ojo et al.).

The projects were viewed generally as areas for priority research. Other comments focused for example on scope, the need for further clarification of objectives and methodologies, and potential problems of execution.

The project proposal on capital goods industry in Zambia raised a number of broad policy questions about why Zambia remained completely dependent on imports for its supply of capital goods and spare parts. However, the project was designed to examine one aspect of capital goods production, i.e., local fabrication and supply of spare parts for industrial production equipment. Its focus specifically is the activities of the railway workshops to ascertain the resources and capabilities of these activities that might be relevant to the production of spare parts for industrial production equipment. The project is to be expanded at a later stage to include the production of other capital goods vital to the Zambian economy. One of the policy questions raised was: Why has the railway industry remained completely dependent on imports of spare parts as long as it has when possibilities for local production could be readily explored? In the discussions of questions and comments on the project, a number of issues were often repeated. These were: the need to assess the availability and accessibility of raw material and intermediate products locally, including iron and steel and machine tools; and the need to ascertain the extent of the capability in Zambia for the local production of capital goods.

The second project on capital goods industry in Nigeria was the opposite of the Zambia project in terms of scope. The project was designed to focus on broad policy questions about the relative underdevelopment of the industry in a country as large as Nigeria in terms of resources, magnitude of economic activities, opportunities for linkage with other productive sectors, extent of market, etc. It posed questions about the feasibility of the simultaneous rather than the sequential development of the local capacity for consumer goods production through import substitution, intermediate goods production, and capital goods production. One of the anticipated results from the project is the delineation of criteria for the design of appropriate industrialization strategy for Nigeria including

the specific role that could be played by the capital goods production sector given overall national development objectives and the socioeconomic circumstances of the country. Comments on the project included the diversity of its objectives and its overall scale, both of which were viewed to be problematic in terms of resource requirements and timetable. Although the project was considered a high priority and an urgent one, the general view was that the initial effort may have to be narrowed considerably to ensure good prospects of its funding and timely execution.

The proposal on metalwork and automobile repairs was designed as a policy study with a major experimental training program component. Although the project was designed with specific trades and small-scale industrial enterprises in the rural and urban sectors of the Nigerian economy as targets, the training component contained potential spillovers into the fabrication of agricultural implements for small-scale farmers. The training component of the project was to identify the various levels of manpower — craftsmen, technicians, and engineers — and to develop alternative instructional approaches to improve the managerial and technical skills of craftsmen and technicians engaged in small-scale industrial activities.

The proposal on processing of agricultural products seeks to: identify relevant socioeconomic factors affecting the selection of methods of processing cash crops and food crops by women at the cottage level in Oyo State, Nigeria; examine the pattern of the government program in the state for improvement in crop production; and delineate the bottleneck in food processing at the cottage level given the increasing scale of mechanization of cash crops and food-crop production and processing. The focus included the problems associated with the adoption of new innovations, equipment and systems, designed to replace traditional processing methods and practices but often rejected by local farmers and food processors. The objective of the study was to understand the local processing methods and practices — types of traditional technology in use, e.g., grinding stone and other techniques, degree of specialization, predominant location(s) of the activities, forms of economic incentives, family life, and traditional responsibilities of women — and the implications of these factors for the adoption of technical changes. Based on this information the project will seek to ascertain what innovative equipment and methods are appropriate (in terms of scale, physical characteristics etc.) and therefore likely to be adopted and diffused. One of the anticipated results from the project would be instructional materials for use in agricultural extension, agricultural economics, agricultural engineering, and home economics.

The next proposal on estimating returns to investment in research and development (R and D) was designed as a preproject study on Nigeria to be followed by a cross-country study of a sample of LDCs. Among the objectives of the project were: to develop a theoretical framework that could help explain the nature, sources, and cost of investment in R and D and returns to these activities in the context of underdevelopment; and to examine several technology policy issues concerning the economics of scientific and technological knowledge formation and how investment in R and D leads to technical change in the private sector and public research institutes in Nigeria and in other LDCs. Other questions and areas of concern in the project included: how underdeveloped are local R and D activities in the private sector and in general in the LDCs?; how effective or ineffective have past R and D activities been in terms of generating technical change and building up local S and T capabilities? Although the general view was

that the project is a high priority one, its execution was considered problematic because of the large magnitude of the work required to accomplish the preproject study and the overall project.

The rural energy project was designed as an extension of the ongoing multidisciplinary study of rural energy systems in Nigeria sponsored by the United Nations University. The extension would involve a search for alternative sources of energy to meet the needs of the rural areas and ascertain what sets of policies are appropriate for the development of a rural energy sector. Comments on the proposal focused on the need to give due consideration to the diversity of activities and practices in the rural sector of the country.

Although work had already been initiated on some of the projects before the workshop convened, all were in varying degrees considered to be of high priority in the effort to contribute to knowledge on S and T policy research in the African region. This conclusion was also confirmed by the results from the session of the workshop on identification of priority research themes.

Follow-up Activities

Follow-up activities consisted of personal research agendas and personal, as well as institutional, commitments to promote the development of several programs and projects including manpower training. These commitments were directly in response to the results of the workshop's deliberations and represent attempts at meeting the needs for S and T policy research in the region. Some of the research agendas, programs, and projects are national in scope, others are regional, or interregional. The activities were drawn primarily from the list of priority research themes identified during the workshop and believed by participants to require urgent attention. The activities are as follow:

(1) Enlistment of the support of ECA and other international and intergovernmental agencies for the training of manpower for S and T policy research in Africa.

(2) Promotion of an effective use of the African Regional Centre for Technology in the conduct of S and T policy research and in the buildup of S and T capabilities throughout the region.

(3) Conduct policy research to upgrade traditional technology.

(4) Promote effective implementation of industrial R and D policy.

(5) Design approaches for the strengthening of engineering and design organizations.

(6) Develop criteria for environmental consideration in the formulation of S and T policy.

(7) Develop a catalog of existing S and T policies in the region and develop appropriate instruments for the implementation of viable ones.

(8) Pursue collaborative S and T policy research between Nigeria and Algeria on the petroleum and iron and steel industries.

(9) Pursue collaborative S and T policy research among West African and East African countries on the capital goods production sector.

(10) Promote the establishment of science and technology policy research units and institutes and the effectiveness of existing S and T research institutes.

(11) Influence S and T policy formulation and implementation.

(12) Conduct policy studies on factor productivity in the agro-allied industries.

(13) Investigate the consequences and implications of rapid technical innovations in advanced countries on African countries and make appropriate policy recommendations to minimize the adverse effects of these (if any) on the economies of the latter.

(14) Investigate the role of technical change in the process of effecting socioeconomic changes in the rural areas and make appropriate policy recommendations from the welfare standpoint of the affected population.

(15) Promote the involvement of the private sector in the conduct of S and T policy studies.

The outcome of the workshop in terms of the priority research themes that were identified and the follow-up activities outlined above represent an important milestone in attempts to develop the field of S and T policy research in Africa and to ensure that its results are effectively utilized in the implementation of national and regional development programs. It is the hope of the workshop coordinators that the importance of this field will soon be widely recognized nationally and regionally and that resources will be made available to pursue some of the research and training programs that countries in the region urgently need. It would also be worthwhile if the ECA through the new African Regional Centre for Technology could encourage these activities nationally and regionally and monitor their performances.

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Appendix 1
Background Documents on Project Identification

Topics for Research Themes[1]

(1) Science and Technology Policy

Less-developed countries do not use S and T policy in their economic development planning process because the importance, role of, and need for S and T policy have not been brought to the attention of the planners and policymakers in these countries. S and T policy, particularly its development, should be an integral part of the economic planning process as this will definitely accelerate and guide economic development. But, many countries do not know how to integrate S and T policy into the economic planning process. In view of this, research should be undertaken to outline: (a) the importance of S and T policy; (b) the role of S and T policy; (c) the need for S and T policy; (d) why S and T policy should be an integral part of economic planning process; and (e) how S and T policy can be made an integral part of the economic development planning policy.

(2) Capital Goods Industries

Recognizing the fact that a genuine emancipation from technological dependence comes about when African countries are in a position to develop and manufacture capital goods, a survey of selected African countries should be conducted to: (a) identify factors that inhibit the growth of capital goods industries; and (b) suggest policy instruments that are required for their future development.

(3) Development and Adaptation of Technology

There is a need to investigate and suggest solutions to bottlenecks and issues that inhibit, within LDCs: (a) the development of indigenous technologies; (b) the adaptation and further development of imported technologies to the point of self-reliance or to the point where reverse technology transfer can occur; and (c) the dissemination and implementation of existing African research results.

(4) Appropriate Technology in Rural Areas

Rural technologies are of primary importance in Africa where upward of 75% of the population is rural.

In view of the fact that little of modern technology from advanced countries has proved to be appropriate to these areas, and bearing in mind the social, economic, environmental, and technical factors, there is need for undertaking research into: (a) the diffusion of the already available technologies in rural areas in selected African countries bearing in mind the contextual factors (social, economic, environmental, and technical); and (b) S and T policies and instruments for appropriate rural technology.

(5) Consulting and Design Engineering Organizations (CEDOs)

Recognition must be accorded to the contribution that CEDOs in Africa could make to the identification of indigenous technology, to the growth of local industries, and to the strengthening of local R and D capabilities.

Some bold strides are presently being made in the protection and expansion of CEDO activities in Africa. The pace of expansion should be quickened because this resource area seems to be one of the first areas of scientific and technological activities to break successfully into the monopoly enjoyed by foreign organizations.

It would therefore be of help to the improvement of these organizations if they were analyzed through a research project. Such analysis should consider those factors that have helped to improve their performance, those that have restrained their development, and those that may influence the design of policies and instruments for their growth.

[1]The original document has been edited for this report.

(6) Manpower

It is necessary for the African countries to develop an appropriate strategy for acquiring technological capabilities in the operation of technologies vital for their development. However, one major constraint exists in the availability of trained manpower (for utilizing the technology). A research project should be supported that would identify policies and the instruments needed to stimulate production of appropriate manpower.

A Priority List of S and T Policy Research Themes for Nigeria

This list is part of a set of background documents prepared for the meeting. Five broad priority areas were identified but not ranked. However, the themes listed under each of the areas have been ranked. Work on themes marked with an asterisk are either ongoing or planned.

(1) Rural Development

*(a) Approaches and instrurnents for the development and effective application of rural technology.

*(b) Technology, entrepreneurship, and public policy — a case study of metal work, automobile repairs, corn milling, and cassava grating.

*(c) Mechanization of agriculture and the choice of farm equipment for small-scale production.

(d) Patterns of social costs/benefits of the utilization of available technology in Nigeria: policy implications.

(2) Industrialization Strategies

*(a) Technology policy and industrial development strategies for Nigeria: (a) mix of industrial development strategies and scale; (b) development of small-scale industries; and (c) development and growth of capital goods industries.

*(b) Selected case studies of technology exchange/transfer in a steel mill, oil refinery, automotive plant, and nuclear reactor.

(c) The development of the transport/communications sector.

(d) Integration of science, technology, and economic policies in national development.

(e) The development of the construction industry.

(3) Management and Manpower

*(a) Estimating demand and supply of scientific and technological manpower.

(b) Assessment of the deployment of local S and T manpower, performance, and job satisfaction.

(c) Cooperation among the ECOWAS on S and T for economic development.

*(d) Methods and criteria for choice-making and effective utilization of foreign technical assistance for national development.

(4) Energy

*(a) Energy policy research — energy demand and supply in Nigeria.

(5) Research and Development

*(a) Linking of research and their findings with productive activities: the performance of research institutes.

*(b) Linking university S and T activities with national development.

*(c) Estimating returns to investment in R and D.

(d) Determining optimum mix of basic research and applied research/experimental development.

Appendix 2

S and T Policy: An Outline of Focal Concerns, Decision Problems, and Tasks for Policy Research

The problem faced by S and T "policymakers" can be conceived as that defined by a set of scientific and technological "functions." A breakdown of these functions is listed below. National science and technology policy is concerned with where and how such functions should be carried out. What should be carried out under each functional heading and how it should be carried out are perhaps the central policy issues. Dealing with these issues requires the decision-maker to answer a set of interconnected questions. A list of such problematic questions is provided below. S and T policy research can be considered as an activity that helps to pose and answer such questions. This requires the prior answering, by research, of broader questions. A list of the kinds of tasks and questions that might constitute the concern of S and T policy research is included below.

Outline of Main Functions within the Science and Technology Systems

(1) Scientific Research

Research activity designed to create new knowledge about natural phenomenon with imminent utility as a minor objective and result of the activity.

(2) Creation of Technical Knowledge (Technology)

R and D activity (plus other less formally organized activities) designed to create new technical knowledge with imminent (expected) utility for the practical processes of production.

(3) Management of the Stock of Scientific and Technical Knowledge

Activities to acquire, store, provide access to, and disseminate stocks of existing scientific and technical knowledge.

(4) Education, Training, etc.

Activities designed to embody in people: (a) selected elements of the stock of scientific/technical knowledge; and (b) abilities to draw upon and contribute to the stock of scientific and technical knowledge.

(5) Incorporation of Technical Knowledge into Production Systems in the Process of Investment

(a) Management: management of the linkage between demand of investment projects and the means used to transform technical knowledge into production systems by "engineering" and by "capital goods" production.

(b) Engineering: formulation of system specifications on the basis of available technical and economic knowledge.

(c) Capital Goods Production: transformation of specification into the "hardware" component of production systems.

(6) Use of Technical Knowledge in the Efficient Operation of Established Production Systems

(7) Use of Technical Knowledge for Ongoing Improvement and Change in Established Production Systems

(8) Implementation of Policy/Designs

Policy (Decision) Problems

(1) What role should be carried out under each "function": (a) within the nation; (b) within the region; and (c) by others in other countries?

(2) How should one control and manage the execution of such function carried out by others outside the country and region.

(3) What level or scale of activity is needed to carry out each function effectively?

(4) What kind of resources are needed to carry out these roles at these levels?

(5) How are these resources to be acquired and accumulated?

(6) How are these resources best organized to carry out the desired roles at the desired levels?

(7) What mechanisms or instruments of policy intervention are necessary to ensure that the answers to questions 1–5 become realities?

(8) How are the answers to questions 1–6 likely to change in the foreseeable future?

Tasks and Questions for S and T Policy Research

(1) What has happened and what is happening with respect to the decision-makers problems?

(2) What are the implications of what has happened and is happening?: (a) What is "wrong," and what are the costs?; and (b) What is "right," and what are the benefits?

(3) Why have things happened in these ways with these costs and benefits?

(4) What alternatives might be possible?: (a) With what costs?; and (b) With what benefits?

(5) Answer the decision-makers' questions 1–8 above.